BOTTS' AIR-SHIP.

The Problem of Aerial Navigation,

BY

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PASO ROBLES, - - CALIFORNIA.

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The inventor is sending out this paper for the purpose of securing financial aid to build a practical working air-ship. Several suggestions are also made, and ideas advanced, in regard to different forms of air-ships. Having applied for a United States patent, and neglecting to explain in the specification the laws upon which the invention is based, when the case came up for examination the Examiner looked upon its successful operation as being somewhat doubtful, without the use of a gas field to suspend it in the air, and the Patent Office held it to be inoperative, calling for a model capable of ascension and propulsion. A machine will have to be furnished before any further action will be taken by the office. This will be a very expensive machine to build and the inventor is not prepared financially to carry it out. He has taken this course, calling for help, by sending out this paper to Scientific and Aeronautical Societies, thus placing it before those who will comprehend the fundamental principles upon which the invention is based. The inventor expects no assistance except by giving undoubted proof that his machin is practical.

The following explanations are given in the form of a discussion between A and B, in order that the points may be brought out more clearly. Believing the following explanations are sufficient to convince the most skeptical, in regard to the successful operation of the machine, the inventor is prepared to correspond with those who may be interested in the invention.

A—Mr. B, I understand you have invented an air-ship, and I am here to criticise on your invention. I am an engineer by profession, and during my life, have made Natural Philosophy a study. I wish now to deal only with fundamental principles. You will understand, Mr. B, that in order to determine the possibilities of an invention, we must look beneath the form, to the law; and there the facts will be disclosed, which will tell the story of its possibilities. Now I wish you to give a clear and exact explanation of the laws upon which your invention is based. I will be your critic while you give your explanation.

B—Mr. A, in regard to the general feature of my air-ship, it consists of a horizontal, cigar-shaped cylinder, with a central, upright, hollow mast. An air-compressor and motor are placed within the cylinder, the cylinder forming the car. The inlet pipes to the air compressor open out at the top side of the car The Outlet pipes extend from the compressor up into the hollow mast. When they have reached a point above the top side of the car, they extend horizontally in opposite directions and at right angles to the length of the car. Their ends then extend vertically downward and form flairing nozzles. The action of the compressor draws the air in through the inlet pipes and throws it out through the outlet pipes. Thus the air entering the inlet pipes vertically downward, will by the so called suction lift the ship vertically upward, and the air flowing vertically downward from the outlet pipes or nozzles, past the sides of the car, in the form of jets, will by reaction from the outer atmosphere, push the ship vertically upward. We thus have the lifting power of the suction nozzles and the outflowing jets of air. The mouths of the air jet nozzles are placed above the center of gravity of the ship, to prevent capsizing, as the main lift comes on them, and they are resting on the pointed ends of cones of compressed air. The mouths of the nozzles are made flairing to prevent the hissing noise of compressed air passing them, which would otherwise occur. A large horizontal plane is fixed on the mast mentioned above, and in case the machinery should cease to act, and the ship start to fall, this horizontal plane is forced sidewise against the air which slides it up a short distance along the mast which it surrounds. This action of the plane opens a valve and admits compressed air from a chamber within the car, to the jet nozzles. The jets of air flowing from these nozzles, form aerial parachutes; and this stored up emergency power will maintain them till the ship can safely descend to the earth. To maintain the ship in an upright position during flight, plumb bobs are fixed upon the car, capable of swinging back and forth and sidewise. In case the ship tilts from an upright position, the plumb bobs maintaining a vertical position, open ports and throw a jet of air from a nozzle extending in the direction to which the ship is tilted. The reaction of the jet of air rights the ship.

A—Mr. B, have you not yet learned that an enormous amount of energy is consumed in producing an air jet whose reaction is comparatively nothing?

B—Yes, Mr. A, I have learned that this is or is not the case.

A—Mr. B, you understand we have been trying for a long time, to get up an air-ship capable of ascension without the use of a gas field. You also understand that no steam engine or other motor, has ever been capable of lifting itself in the air. The difficulty Mr. B, has been this: we have never been able to get a motor sufficiently light, for the amount of energy it produced. It simply consists in securing a lighter motor with a greater power. When we advance far enough in this direction we will navigate the air.

B—Mr. A, I am prepared to tell you I have a different course to pursue, from that which you mention. I have discovered a way to double, quadruple and multiply the lifting capacity of an air-ship, almost without limit. Mind you, this can be accomplished without increasing the weight or power of the motor, or weight of any part of the air-ship. You understand the different motors as we have them now in their present condition, are capable of lifting themselves into the air and many times double their weight. They already yield sufficient mechanical power to do all this. But in all air-ships so far, the main portion of the power has been wasted, because it has never been properly applied. It has not been the plans and forms of the air-ship which were at falt, but their proportions and incline surfaces and the like. It seems that these inventors or builders of air-ships have not understood the laws upon which their inventions were based; and the rusult is, they have not had those laws to guide them to success. It has been like trying to solve a problem in mathematics without a rule,

A—But Mr. B, I want an explanation about how you are going to increase the lifting capacity of your air ship without increasing the power of the sustaining motor.

B—Mr. A, it is accomplished by air jets of large volume, under low pressure and velocity.

A—Mr. B, do you mean to say that a jet of air of large volume under low pressure and velocity, lifts a greater weight than one of smaller volume with high pressure and velocity, with equal amounts of energy consumed per second in each case?

B—Yes Mr. A, that is just what I mean to say; let us force a large volume of air under low pressure and velocity, through passages of large dimensions, and we are on the road to success. For illustration, we will take two air-ships exactly alike in form and weight, but in one the nozzles and aerial passages throughout contain greater diameters than the other. To be exact we will say they contain just eight times the area of the other. A given power with the enlarged area, will lift just double the weight to that in the other case, nor is it necessary to increase strength or weight of the parts upon which the strain of the compressed air rests, for the reason that as the dimensions of the parts are enlarged, the air pressure per square inch is reduced proportionally.

A—I understand your theory Mr. B, now I ask you to prove all this. It is very easy to say this is so and so, but it is another thing to prove it.

B—you are aware of the fact Mr. A, that if we double the velocity of a body moving through the air, we will quadruple its resistance. Suppose Mr. A, we have two parachutes; one has an area of one hundred square feet, and the other an area of four hundred square feet. We place on these parachutes loads which make them descend at equal velocities. We place on the larger one a load of one hundred pounds, and in order to make them descend at equal rates, we place on the smaller one a load of twenty-five pounds, for the reason that it contains only one fourth the area of the larger one. Now if we place a load of one hundred pounds on the smaller one, this load will cause it to descend at such a rate that it will be constantly meeting with the same resistance from the air as that of the larger one at its slower velocity. And this rate will be double that of the larger one, for the reason that we have quadrupled its resistance against the air, by doubling its velocity. Thus you observe, if we quadruple the area of a parachute, it is compelled to descend at only one half that of its former rate, in order to meet with the same resistance. In this case of the falling parachutes, the parachutes themselves are supposed to contain equal weights.

Suppose Mr. A, we have a combination consisting of a steam engine and boiler; and on the outer end of the piston rod we have fixed a broad plane having an area of one hundred square feet. Suppose we so arrange this combination that the piston rod by the action of the steam, moves the plane constantly vertically downward sidewise against the air. We will call this combination an illustrative air-ship. The plane being moved vertically downward, reacts against the air and tends to lift the ship and hold it in the air. Suppose this plane has to be moved downward against the air, at the rate of one hundred feet per second, in order to gain sufficient reaction to sustain a weight of one hundred pounds. We now remove this plane and replace it with one having an area of four hundred square feet. Now according to the laws illustrated in the case of the parachutes, the engine has to move this larger plane at only fifty feet per second against the air, in order to gain sufficient reaction to sustain a weight of one hundred pounds. What is this we have? A plane with an area of one hundred square feet, moving against the air at the rate of one hundred feet per second and sustaining a weight of one hundred pounds. And in the second case a plane having an area of four hundred square feet, moving at the rate of fifty feet per second and sustaining a weight of one hundred pounds. Now in the first case, the engine has to move a load of one hundred pounds, at the rate

of one hundred feet per second, in order to sustain a one hundred pound weight. And in the second case, it has to move a load of one hundred pounds, at the rate of only fifiy feet per second, to accomplish this. Mr. A, you are well aware of the fact, that it requires double the power to move a load at the rate of one hundred feet per second, to that which is required to move it at the rate of fifty feet per second. You now observe the advantage of the larger plane. It only required one-half the power to sustain the one hundred pound load, by using the larger plane, to that which was required to sustain the same load with the smaller plane. So then it comes to this: We can lift the one hundred pound load with one-half the power, if we quadruple the area of the plane. Now if we choose we can double this quadrupled area of the plane and lift two hundred pounds instead of one, by using the full power of the motor. Mr. A, you are probably aware of the fact, that in the case of the well known water wheels, where the power is applied by throwing jets of water against paddles fixed upon their peripheries, that they require gearing according to the velocity of the jet by which they are actuated. A large jet under low pressure and velocity, rotates the wheel with great force, but at a slow rate of motion; and a small jet under high pressure and velocity, rotates its wheel at a high velocity, though it has but little force, till we introduce gearing to decrease the motion and increase the purchase. Keep in memory the fact, that in the case of both the large and small jets, they are supposed to transmit equal amounts of energy per second, from their nozzles to their wheels. It is clear Mr. A, that the constant strain between the nozzle and paddles on the wheel, in the case of the larger jet with low pressure and velocity, is greater than that in the other case, although they are transmitting equal amounts of energy per second, from their nozzles to their wheels.

Mr. A, I read an account in a Scientific paper, which illustrated this law: The statement was made that a spiders web forming a belt and placed on pulleys correspondingly dellicate, would by traveling at the velocity of light, transmit about two hundred and fifty horse power. You are aware of the fact, Mr. A, that in that case an enormous amount of energy would be transmitted from point to point per second, but the strain upon the vehicle which conveyed this energy would be excedingly small. Now Mr. A, the larger plane in the case of the illustrative air-ship, and the larger jet of water in the case of the water wheels, represent the larger jet of air in the case of the air-ship. They illustrate the fact, that as we decrease their velocity, we increase their pressure or reaction; And in the case of the spiders web traveling at the velocity of light, the fact is shown what a great amount of energy can be transmitted from point to point per second in the case of the air jets with but little pressure or reaction as in that of the spiders web, Now we may consider it a natural law, that for transmitting a given amount of energy, in a given time from point to point, as we increase the velocity of the vehicle conveying this energy, the constant strain or pressure on this vehicle is decreased, no matter what form or nature this vehicle is. It may be planes of air-ships moving directly or indirectly against the air. It may be a belt fixed on pulleys, a revolving shaft or a reciprocating piston rod, a jet of water or a jet of air. These are all simply cases of transmission of energy from point to point. To make this case more clear, in regard to transmitting energy from point to point, we will for illustration suppose a belt to carry one hundred pounds at the rate of ten feet per second. It will then transmit from point to point one thousand foot pounds of energy per second. We now suppose the belt carries a load of fifty pounds; you understand then it will have to carry this load at the rate of twenty feet per second, in order to transmit the one thousand foot pounds per second. You observe in this case, that we doubled the velocity of the vehicle and transmitted the one thousand foot pounds per second, though the strain upon the vehicle was only one-half that in former case. This then makes it clear, that as we increase the speed of the vehicle carrying a given amount of energy per second, we lessen the strain upon it, and yet convey the same amount per second as before. Now in the case of the air jets, they are similar to bent springs placed between bearings. The springs being in a state of tension and pressing equally against each of their bearings. The mouths of the nozzles form one of their bearings and the outer atmosphere the other. And the weakest points in the air-jet springs (shall I call them) are immediately at the mouths of the nozzles, where the velocity of the jets are greatest.

A—But Mr. B, I suppose we shall have to give up the idea that a small propeller moving at a high velocity, will bring about as great a reaction as a large one moving at a slow velocity, with an equal power in each case to actuate them.

B—Yes Mr. A, that idea will have to be given up in all forms of propellers. A plane moving broad-sided directly or indirectly against the air, is practically the same; and this law we have been

discussing applies to all.

A—Then Mr. B, You mean to say this law applies to all air-ships, such as those using horizontal screws, aeroplanes etc.?

B—Yes Mr. A, it applies to all, independent of their form. You understand Mr. A, that in the case of propellers moving against this yielding medium, —the atmosphere, our object is to secure a foothold; and if this foothold yields in the least, under the pressure of the propeller, it means just that much dead loss in the energy of the motor. The larger then the surface of the propeller, moving against this yielding medium, the better is the foothold, and the less the loss of power. In order that there be no loss of power, the area of the propeller must be brought to such great dimensions, giving such a great foothold on the air, that it will not yield at all from the pressure of the propeller. But these dimensions can never be reached, either in practice or theory. The practical dimensions which may be reached, can only be determined by experiment. So we may conclude without a doubt, that in all air-ships of the coming future, at best, we will always have a heavy and unavoidable loss of energy from this source.

A—Mr. B, in regard to a revolving horizontal screw, I suppose you mean to crowd the air vertically downward, thus gaining the reaction to lift the ship.

B—Yes Mr. A, that is the idea.

A—Mr, B, suppose I had an air-ship on this plan, what change would I have to make, to double its lifting capacity, without increasing the power of the sustaining motor?

B--You would have to multiply the area of the blades of the screw to eight fold.

A—Mr. B, I would like to ask you the same question in regard to the air-ship with aeroplanes.

B—Mr. A, suppose in the cases I am about to explain, that the air-ships during their flights are to remain at a constant elevation, and in all cases to move at the same rate, and exactly horizontally. Now Mr. A, you may double the lifting capacity of the ship by multiplying the area of the aeroplane to eight fold, and fixing it at such an incline from a horizontal position, that it will crowd the air downward from its under surface at one-half that of the former rate. In this case the area of the blades of the screw which propells the ship, do not have to be modified. And there is another way Mr. A, in which you can double the lifting capacity of your ship without increasing the power of the sustaining motor. It is accomplished by doubling the area of the aeroplane and letting it remain at its former incline, And then multiplying the areas of the blades of the screw to eight fold.

A—Mr. B, in regard to modifying the area and incline of the aeroplane, and areas of the blades of the screw, in order to double the lifting capacity of the ship without increasing the power of the sustaining motor, I want you to explain this: Why are these particular changes necessary to bring about this result?

B—Mr. A, They are in harmony with the law pointed out in the case of the illustrative air-ship, where the fact was shown we might by multiplying the area of a plane to eight fold, and allowing its surface to move against the air, either directly or indirectly at one-half its former rate, double the lifting capacity of the air-sqip. Now in regard to the ship with the aeroplane; You multiplied the area of the aeroplane to eight fold, and fixed it at such an incline that itwould crowd the air down at only one-half the former rate. The aeroplane now descends in the yielding air at only one-half its former rate. And at the same time it is gliding upward, I might say at one-half the former rate, thus remaining at a constant elevation. The aeroplane now, does not have to be pushed up so steep an incline as before. With its load it has only to be glided upward in the air half so high in a given time, and decends only half so far in that time. For this reason it will sustain double the load with the former power, and in regard to the second case of modifying the aeroplane, you double its area and lift it at its former incline. This doubled area calls for double the horizontal pressure, to move the ship at its former rate carrying double the load, because of the incline of the aeroplane not having been changed, and was compelled to glide upward in the air at as steep an angle as before any modifications were made and at the former rate. Or we can illustrate the case equally clare by saying, the aeroplane crowded the air downward, and this doubled horizontal pressure was then secured by multiplying the area of the blades of the screw to eight fold. Now the explanation of the modified areas etc., of the screw blades of the air-ship using horizontal screws, explains the philosophy of those on the ships using aeroplanes. The revolving horizontal screws crowd the air downward practically the same as the plane in the case of the illustrative air-ship, as do the aeroplanes, for the inclined blades of the screw are only aeroplanes moving in a circular path; and in the case of the illustrative air-ship, it was shown that when the area of the plane was multiplied to eight fold, we could lift double the weight without increasing the power, for the same reason we can do so in this case. Accrding to fundamental principles we are not confined to any particular

incline in case of the blades of the horizontal screw. If we modify their incline, and cause their plane to lie more nearly parallel to the plane of rotation of the screw, then they can not crowd the air so far away during each revolution of the screw. The velocity of the screw would then have to be increased in order to move the air away at the same rate at which it was moved before we modified the incline of the blades. And since we have this modification, it will simply result in a higher velocity of the screw. In the end the screw would move the air away at the same rate as before we modified the incline of its blades. Let me say Mr. A, that experiment might prove a particular incline of the blades of the screw to be of the greatest importance, even if general principles do indicate the reverse. Now I desire to suggest, Mr. A, a plan for an air-ship whose power is supplied by stored compressed air. It contains a long horizontal cylinder filled with compressed air at a very high pressure. The cylinder forms the body of the air-ship. Enlarged nozzles are to be placed along the sides of this cylinder, one row on each side, the rows extending along the full length of the cylinder with their mouths extending downward. The nozzles in each row are placed one immediately in the rear of the other. During the flight of the ship, the nozzles in each row will all move through the same path and present little surface for resistance against the air. Their mouths which are the points of suspension for the ship, are placed above the center of its gravity to prevent capsizing. The compressed air will flow through small pipes into the enlarged nozzles and there expand and produce a lower pressure before passing out from them into the open air. Thus we have by means of the enlarged nozzles large volumes of air flowing from them under low pressure and velocity, which produces a far greater reaction or lifting power, than had the compressed air flown directly into the outer atmosphere before descending to a lower pressure and larger volume. We also have a large number of enlarged nozzles, thus securing great nozzle area and consequent economy of power. In regard to the appliances to maintain the ship in an upright position during its flight, and to prevent it from falling in case of accident, the arrangements mentioned in the air-ship above, using air jets, are equally adapted to this case. But you will understand Mr. A, that the ship could not travel as long journeys as those carrying an engine and feul. It would have to land occassionally for a renewed supply of compressed air. You understand it is possible to carry only a fraction of the energy in the form of compressed air, to that which may be carried in the form of oil, coal etc.

A—Mr. B, I want to suggest placing a small engine on a ship of this kind, and when on a long journey land occassionally and supply fuel for the engine, and charge the ship with a new supply of compressed air while resting on the earth. Now Mr. B, would there not be a great loss of energy by the compressed air descending to a low pressure before passing out from the enlarged nozzles?

B—Yes, but the material from which the energy is extracted is not carried on the ship, so it makes no difference as far as the air-ship is concerned.

A—Mr. B, in case the cylinder is of large dimensions, but thin and light, it would hold a large quantity of air at a low pressure; but if its dimensions are smaller it would have to be very thick and heavy in proportion to its dimensions, to hold the same quantity of air, because of the higher pressure which is brought about. Now it is desirable to have the dimensions of the cylinder small as possible in order that it may be less bulky. But the smaller cylinder must hold an equal amount of air to that of the larger one, independent of its pressure. We must have the large quantity of air independent of the dimensions of the cylinder, or pressure of the air within it.

A—Mr B, I want to ask you this question: Would there be any difference in the weights of the large and small cylinders, capable of holding equal quantities of compressed air at the different pressures?

B—Suppose Mr. A, we have a cylinder one foot long and one foot in diameter, and we have another one one foot long and six inches in diameter. Each cylinder is made of one-eighth inch steel. We will compress within the larger cylinder two cubic feet of air from its normal pressure to one atmosphere. We will compress within the smaller cylinder one cubic foot of air The pressure in the larger cylinder we suppose to be fifteen pounds per square inch, and in the smaller one thirty pounds per square inch. The smaller cylinder has a strain double that of the larger one, but it can stand double the pressure, because it contains only one-half the diameter of the larger one. The smaller cylinder contains one-half the quantity of air to that of the larger one, its weight is also one-half that of the larger cylinder, and we suppose the two cylinders contain all the pressure they can bear. Now if we make the smaller cylinder of one-fourth inch steel in place of one-eighth, as before, we double its weight and strength. And being thus strengthened we can compress within it twice the quantity of air it contained before. It will then con-

tain the same weight as the larger cylinder and the same quantity of air, You then observe that their weights are the same in order to have sufficient strenght to stand the pressure brought upon them, by containing equal quantities of air.

A—But Mr. B, if the compressed air flows from the smaller cylinder, under its high pressure, into the enlarged nozzles, and there descend to a low pressure before passing out from them, there is a much greater amount of energy wasted than in the case of the large cylinder; because the pressure of the air must descend from thirty pounds per squar inch in the case of the smaller cylinder, before doing useful work, and in the case of the larger cylinder it would only have to descend from fifteen pounds. You understand that in the case of the smaller cylinder, the compressed air contains much more energy than that of the larger one, although the quantity of air contained in each cylinder is the same. Now Mr. B, we must necessarily have this high pressure in order to reduce the bulk of the cylinder. But I cannot fancy this enormous waste of energy. Can you suggest a way to prevent this loss?

B—Mr. A, I suggest placing an air compressor on the ship, and allow the stored compressed air from its reservoir, to actuate this compressor while in the act of descending to a low pressure, and allow the exhaust from the compressor, which would contain sufficient pressure to supply the enlarged nozzles. The compressor then in return can compress more air into the reservoir from which it received its energy, thus there is no loss of energy from that source. The extra weight added in the shape of machinery, is small in comparison to the power saved. Now Mr. A, with all our different air-ships, (those useing air jets, aeroplanes, horizontal screws etc.,) We have made these changes and doubled their lifting capacities, without increasing the power of the sustaining motor. The fact is then clear, that we can in a similar way, increase their lifting capacities without limit, so far as this law is concerned The practical limit can only be determined by experiment. In closing our discussion in regard to increasing the lifting capacities of the air-ship, I will say the point we have been discussing is based on that all-important natural law, that to get the greatest reaction with a given power, we must have the greatest area moving against the resisting medium at the lowest velocity.

A—Now Mr. B, while we have all the advantages of your plans, we must not over-look the fact that it is desirable still to have the lightest possible motor with the greatest power, to operate our air-ships. Can you suggest the plan of an engine which would be lighter than those we now have? You understand by increasing the dimensions of the parts in the air-ships as you have suggested, that they are necessarily somewhat bulky, which is not desirable, as there is a greater surface to move against the air during their flight. And securing a greater power to a given weight of motor, means either to decrease the dimensions of the air-ship, or carry a greater load.

B—Yes Mr. A, there is plan by which this can be accomplished. It consists in working the steam at the lowest possible pressure. We suppose we have a boiler furnishing steam at a high pressure; This high pressure calls for strong and heavy parts upon which it exerts its pressure. Suppose this boiler furnishes steam at a pressure of one-tenth that of the former. The reduction in pressure will permit us to reduce the strength and weight of the parts upon which the pressure comes, to one-tenth that of the former. Yet this boiler generates as many foot pounds of energy in a given time as before, for the reason that this depends on the heating surface. The heating surface being as great as it was before, it then comes to this: We have reduced the weight of the boiler to one-tenth that of its original and yet it generates as much energy in a given time as before. But since we have reduced the steam pressure, we will have to increase the dimensions of the steam chest to permit the low pressure to do mechanical work as fast as it is generated. You understand we must have a greater piston area. The area must be increased in proportion that the steam pressure has been reduced.

A—Now Mr. B, how abont diminishing the weight of the water in the boiler?

B—Mr. A, in case the water is contained in the spaces among the flues of the boiler, the flues then should lie more closely together, thus giving less water space. It would then require less water to fill the boiler and cover all the heating surface. The small amount of water then in the boiler would be converted into steam and pass out more quickly into the condenser, to be returned by the injector. The result would be, that the smaller amount of water is used over more frequently in a given time. It would probably be advisable to let the flues contain the water and allow the heat to pass through the spaces among them, for the reason that their diameters being small, they will stand the pressure with less thickness and weight than in the case where a cylinder of larger diameter surrounding the flues, is required to stand the strain. This cylinder will require great strength and

weight because of its large diameter. And for this reason, allow no parts with large dimensions on which the steam pressure comes. In this latter case only a light hull is required to surround the flues, to confine the heat to its path. And it would require a greater internal strain to burst these tubes than external pressure to collapse them. Now in this case, to secure the greatest heating surface with the smallest water space, the flues containing the water should have as small a diameter as possible, because if we lessen their diameters one-half, we will lessen the amount of water they contain to one-fourth that of the former amount, and only lessen their heating surface one-half. They may be made much lighter with sufficient strength to stand the strain, because of their smaller diameters.

A—Mr. B, while all these air-ships we have been discussing, may be satisfactory for slow velocities, we cannot satisfy our selves without higher velocities. We should travel several hundred miles per hour, to carry our mails, if not passengers. Are there not fair prospects that we will soon advance to this point?

B—Mr, A, You have probably observed the flight of different birds—we take the crane and the duck for illustration. You will observe the crane is possessed of wings, or sustaining mechanism, with very large surfaces, in comparison to its weight, to move against the air. But the reverse is the case with the duck. Now the condition of the crane with the large surface of its sustaining apparatus, means the greatest economy of the energy stored within its body, because of the great areas of its wing moving slowly against the air, being an exact representation of the enlarged areas of the sustaining surfaces of air-ships. The duck possesses on the contrary a very heavy body in comparison to the area of its wings, and you will observe during its flight that its wings move against the air at a very rapid rate, in order to sustain the comparatively great weight of its body. This means a great waste of its stored energy, and is a representation of the sustaining surfaces of air-ships with small areas. Now Mr. A, it is not difficult to observe the difference in the flight of these two birds. The flight of the crane being exceedingly slow and awkward, and the reverse being the case with the duck. Now while the duck during its flight, loses far more energy per second, to each pound weight of its body than the crane, it has the conditions present to enable it to reach a far greater velocity; and these conditions could not be present without this heavy loss of energy.

A—Mr. B, what are these conditions that enable the duck to reach its rapid ascension and flight?

B—Mr. A, you will observe the duck to be more compact than the crane; this is a condition suitable to rapid flight. But most important of all is the fact, that it possesses the possibility of withdrawing from its source a far greater amount of energy in a given time, to each pound weight of its body than that of the crane. And in regard to the mechanism of the duck, which this energy must actuate to bring about the rapid ascension and horizontal flight, it is undoubtedly a fact that the rapid flight is brought about by such a motion of the wings that they force the air more nearly directly backward, and at a more rapid rate than that of the crane. And the small sustaining surfaces or wings of the duck moving downward against the air at a rapid rate, have a tendency when they have released the weight of the duck from its place of rest, to cause it to ascend with a bound similar to that of a sky rocket, and for a similar reason; while the crane with its enlarged sustaining surfaces moving downward against the air at a slow veloity, is incapable of bringing about such a result.

A—But Mr. B, what has all this about the duck and the crane to do with air-ships?

B—It is my object to compare the build and proportions of air-ships to the build and proportions of the duck and crane. You will observe the comparatively bulky, awkward and slow motioned air-ship with large sustaining surfaces representing great economy in power, to be a representation of, and is built on the plan of the crane. But Mr. A, if we hope to reach any great velocities with our air-ship we must have the conditions of the duck. We must have the conditions present from which we can withdraw an enormous amount of energy in a short period of time. You understand we require a very large number of foot pounds of energy per second to each pound weight of the ship, in order to handle it quickly. The ship must, like the duck or sky-rocket, be capable of rising from the earth with a bound. It must not consume an hour in rising a thousand feet high, but must quickly rise to an altitude from which it takes its horizontal flight, for the object of this ship is to travel the greatest possible distance in a given time. And its rapid ascension is required for the reason that it must land frequently to renew its store of energy. When we secure our energy and bring about the conditions in order that it may be used rapidly as desired, we will, like the duck, be able to ascend and travel horizontally with great velocity. But remember, the greater portion of the energy, as in the

case of the duck, will necessarily be lost in bringing about these conditions for rapid flight. You understand that the sustaining surfaces of the ship, like that of the duck, will be small and suitable to rapid flight.

A—Mr. B, I want to know something about how we are going to bring about the conditions of the duck in our air-ship? Will the possibilities of mechanics and sources of energy permit thist to be accomplished?

B—Mr. A, while we have not quite reached the possibilities of mechanics necessary for this condition, it seems as though it would not require much invention to bring it about. And I will say that gas and petroleum engines appear to be most suitable. There appears no reason why they can not be reduced to an excedingly small weight—to as low as two or three pounds per horse power I will venture to say. And in regard to their sources of energy, they ful-fill that all-important condition, in supplying the energy fast as required. We do not require all this heavy machinery, boilers, water condensors and so on, to be carried on the ship, as in case of the steam engine, to bring about that result. When we have thus reduced the weights of the engines, we have that difficulty practically removed. In regard to the weight of the fuel, we need fear no difficulty, when it is considered that one pound of petroleum contains fifteen million foot pounds of energy; and there is no reason why we cannot secure two-thirds of this for useful mechanical work, when we make a little more progress. All we require is to bring to perfection the gas and petroleum engines, and we can soon have an air-ship, capable of traveling at a great velocity in the face of the heaviest tornado that ever blew.

A—Mr. B, from what source will you secure your gas in case you use a gas engine?

B—It will be stored at a very high pressure in a reservoir on board the ship. If you care to make the calculations it will not be difficult to determine the number of foot pounds of energy which can be thus stored, to each pound weight of the reservoir.

A—Mr. B, In order then that our ship shall reach this great velocity, and in view of the fact of its heavy loss of power even if we have on board a large supply of energy, it will sooner or later become exhausted.

B—Stations shall be arranged at suitable points along the air-ship line where the ship lands and secures new supplies of energy. And the distance apart at which these stations should be placed will depend on how far a supply of energy will carry the ship. While the ship consumes its supply of energy in a short time, with its great velocity it will travel a great distance during that time. And here let me remark, that the above mentioned air-ship with the stored compressed air and enlarged nozzles is suitable to operate on this plan.

A—Mr. B, What is your idea in regard to transforming the energy of petroleum directly into electricity? Of course you are aware, if it can be accomplished, of the advantages which would result, to aerial navigation.

B—While such a discovery would be of priceless value, it seems to me that it will never be made. Yet there is such a great unknown just before us—so much to discover and so little that has been discovered that we know not what is in store for us. Mr. A, you are aware that by decomposing zinc with an acid that its stored energy, its chemical affinity, is released and comes forth in the form of electricity. But suppose you try decomposing iron or steel with this acid, and its energy comes out in the form of heat, with no electricity about it. I believe the reason zinc gives forth electricity, is because of its extraordinary chemical constitution, which no other material known to the writer possesses; and it seems that it is not likely that petroleum possesses this condition in the absence of that in thousands of other materials which do not possess it. To come right to the point Mr. A, it is undoubtedly a fact, that the mode of the atomical motion brought about by the decomposition of zinc, is alltogether different from that of other materials, and this mode of motion happens to be the same as that brought about in the coils of a dynamo by the magnets passing them. Heat is evidently a simple reciprocating atomical motion. While in the case of electricity, we have the best of evidence by its manifestations, if not positive proof, that it consists in a rotary reciprocating motion, of polarized atoms on an axis. It seems to me that a familiar substance like patroleum, if it contains the possibility of giving forth electricity, would have given some manifestation of it through accident or experiment. Now Mr. A, while I hope my views are wrong in regard to this, I fear they are correct. And if they are, there will be other methods developed which will contain as small a weight per horse power in machinery as is possible in this case.

And in bringing our discussion to a close, I will venture to say that the dawning of the twentieth century will find us operating air-ship lines across continents exploring the unknown regions of the earth by their aid, and possibly soaring across the seas.

Barnet N. Botts,
Paso Robles,
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